System Specification

PCM Interface Thread, Thor DP1

Checkout and Launch Control System (CLCS)

84K00302-009

PCM Interface Thread Assessment

March 12, 1998

Version 1.0

PCM Interface Thread Assessment
Table of Contents

Assessment Team

Name	CI Represented	E-Mail Address	Phone
Shawn Quinn	Thread Lead	Shawn.Quinn-1@ksc.nasa.gov	861-7608
Chau Le	PCM Services CSCI Lead	Chau.le-1@ksc.nasa.gov	861-2293
Charla King	Test Build	Charla.King-1@ksc.nasa.gov	861-7587

1. Introduction

1.1 PCM Interface Thread

This thread establishes the initial capability to monitor PCM link FD's. Recording, Retrieval, Data Bank, Application Services, Display Services, Data Distribution, System Build services and Test Build services will support basic CCMS format PCM FD's. Displays developed in Redstone for Super Light Weight Tank will be used to display FDIDs processed by the PCM Downlink Gateway.

The Space Shuttle Main Engine, Pulse Code Modulation (PCM) downlink interface consists of three separate one-way telemetry data streams from the Orbiter Main Engine Controllers (MEC) via the Engine Interface Units (EIU). This downlink is the primary method for the Space Shuttle Main Engine s to communicate measurements, health, and status to the ground system.

Note: Space Shuttle Main Engine PCM Support will not be provided for Thor.

1.2 PCM Interface Thread Concept

To provide PCM Interface Support as defined in the Thor Delivery Document Section 6.2.3 requires support from the PCM Gateway and all other major CLCS Systems.

PCM Interface Thread Concept Diagram
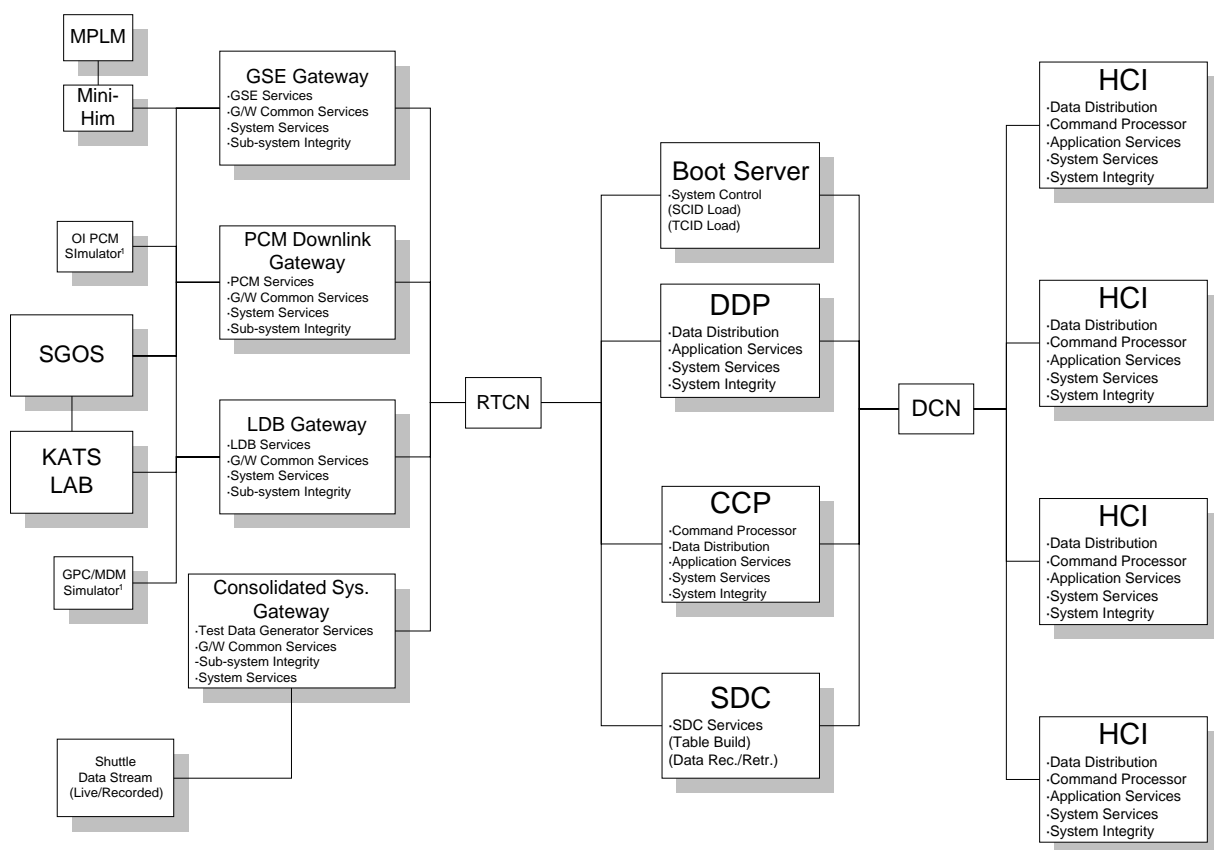
1. Gateway Team developed test tools

1.3 PCM Interface Thread Specification

1.3.1 Statement of Work

- Provide support for 128 kbits OI/GPC ,and Space Shuttle Main Engine 60 kbits links.

  Space Shuttle Main Engine PCM Support will not be provided for Thor

- Provide the Test Build Services capable of supporting the PCM FD's, including PCM Gateway Table Generation and On-Line Data Bank Generation.

- Provide a PCM Gateway capable of decom a CCMS formatted PCM link and providing Change Data Packets via the RTCN at the system synchronous rate (5-50msec).

- Provide the capability to detect and report PCM Link Errors and update the FD Status appropriately.

- Provide the capability to load/reload the PCM Gateway Tables in the Gateway.

- Provide the initial capability to record and retrieve the PCM FD's via Shuttle Data Center .

- Provide the application services required to support display of PCM FD's.

- Define and support the PCM measurement FD's (AM, DM, DPM, 32 Bit GPC Floating Point, Support for 64 Bit GPC Floating Point).

- Provide support for enable and disable processing.

- Provide support for enabling and disabling collection and distribution of all samples of selected FD's.

- Provide support for modification of calibration and engineering units.

- Provide support for format changes

- ***Provide capability to log entire PCM frame(not supported for Thor)***

- Provide support for super commutated Space Shuttle Main Engine FD's

  Space Shuttle Main Engine PCM Support will not be provided for Thor

- Provide a user display capability to display PCM Data Types

- Build, load, distribute, and initialize all TCID table and SCID software require to support PCM operation.

1.3.2 Requirements

SLS Requirements addressed in this thread:

- (SLS - 2.1.1.2) Orbiter OFI PCM Downlink Interface

The Operational Flight Instrumentation (OFI) Pulse Code Modulation (PCM) downlink interface consists of a one-way telemetry data stream from the Orbiter PCM Master Unit (PCCMU). This downlink is the primary method for the Orbiter to communicate measurements, health, and status to the ground system.

The Orbiter OFI PCMMU transmits Operational Instrumentation (OI) data, GPC data, and Payload (PLD) data in a Bi-Phase-L time division multiplexed data stream at 64 Kbs, 96 Kbs, 128 Kbs, and 192 Kbs. The 96 Kbs and 192 Kbs data streams contain 32 Kbs and 64 Kbs of voice data respectively. The voice data is not directly processed by RTPS. The downlink may consist of several variable length and content formats. The signal is a unidirectional continuous data stream using bi-phase Manchester II encoding. At the CLCS Gateway, the electrical signal will be differential 2 VP-P +/- 0.2 VP-P at 124 Ohms balanced.

- (SLS - 2.1.1.2.1) The RTPS shall provide the capability to receive, decommutate, and process PCM downlink information from the PCMMU as described in:
  1. ICD-2-0A003, Flight Vehicle/LPS Computational Systems Interface
  2. ICD-2-19001, Shuttle Orbiter/Cargo Standard Interfaces

3. SS-P-0002-140, Space Shuttle Downlist/Uplink Software Requirements

- (SLS - 2.1.1.2.2) The RTPS shall provide the capability to receive, decommutate, and process payload PCM downlink information as described in:
    1. ICD-2-0A003, Flight Vehicle/LPS Computational Systems Interface

- (SLS - 2.2.2.2.1) All PCM Downlink and GSE gateways shall be able to support full link capacity with all measurement values changing every sample with no checkpointing active and while receiving 10 End-Item commands per second (GSE only) per Table 2.2.

1.4 PCM Interface Thread Hardware Diagram

The following diagram illustrates the major hardware elements in the PCM Gateway. The hardware elements enclose by the dashed line reside in the Gateway VME Chassis.

PCM Gateway Hardware Diagram
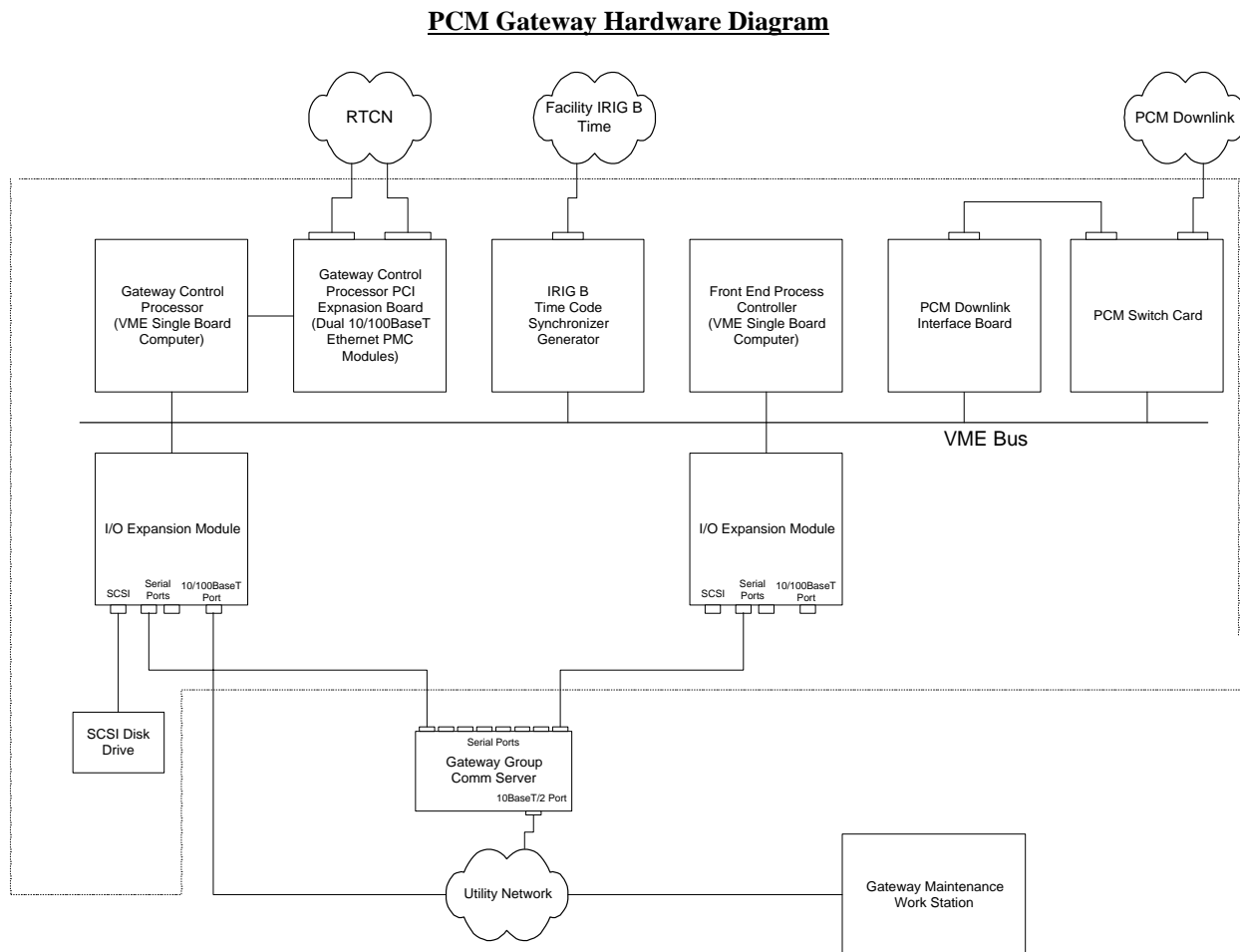
1.5 PCM Interface Thread Deliverables

Software:

Deliverable	R&D Document	Code	API Manual	Users Guide
PCM Services CSCI	X	X		

Hardware:

Deliverable	R&D Document	Drawings	Prototype	Users Guide
PCM Gateway SDE-1			1	
PCM Gateway SDE-2			1	
PCM Gateway IDE-1			1	

1.6 PCM Interface Thread Assessment Summary

This section contains the summary of the costs and labor involved in implementing PCM Interface Thread capability. It is broken into three sections. The first is a summary of the individual CI (CSCI and HWCI) labor assessments. The second is a summary of hardware costs. The third is a summary of procurement activities needed.

1.6.1 Labor Assessments

The total Labor Costs required to provide this capability are summarized in the following table;

No.	CSCI/HWCI Name	Thor LM	Changes covered in
1	PCM Services CSCI	16	PCM Interface Thread
2	PCM Interface Board	2	PCM Interface Thread
3	Gateway Control Processor/Front End Processor Controller HWCI		GSE and Gateway Common Services Completion Thread
4	Gateway IRIG-B Interface Board HWCI		GSE and Gateway Common Services Completion Thread
5	GCP Common Services CSCI		GSE and Gateway Common Services Completion Thread
6	Test Build & Control	18	PCM Interface Thread Completion Thread
7	System Services CSCI (System Control CSC)		System Services Enhancement Thread
8	Command Support CSCI		Commanding and Command Processor Phase 2 Thread
9	Data Distribution		Data Distribution Completion Thread
10	System Services		Reliable Messages Completion Thread
11	Application Services		Data Distribution Completion Thread/ Commanding and Command Processor Phase 2 Thread
12	System Viewer		System Viewers Thread
13	Data Recording/Archival and Retrieval		Log, Record and Retrieval Phase 1 Thread
	TOTAL	36 LM	

1.6.2 Hardware Costs

All PCM hardware to support development efforts in the SDE 1, SDE 2, and IDE 1 with the exception of the PCM Downlink Interface Board is currently on hand or already on order.

The total Hardware Costs required to provide this capability are summarized in the following table:

Item number	Name	Unit Cost	Qty.	Total	Assumptions
1	PCM Downlink Interface Board	$12,000	5	$60,000	New Buy

1.6.3 Procurements

Pre-production PCM Downlink Interface Boards will be procured to support Thor PCM Interface Gateway development activities.

Procurement Activity	Completion Date
Define PCM Interface Board Requirements	10/17/97
Submit Purchase Request to Procurement	10/21/97
Award Contract	10/24/97
Receive PCM Interface Boards	11/24/97

1.7 PCM Interface Thread Schedule & Dependencies

1.7.1 Schedule

Task Name	Start	Finish
Thor Assessment Kickoff	9/8/97	9/8/97
Concept Panel Internal Review	9/23/97	9/23/97
Concept Panel	9/25/97	9/25/97
Thor Development		
PCM Downlink Services CSCI Requirement Panel Internal Review	11/4/97	11/4/97
PCM Downlink Services CSCI Requirement Panel	11/6/97	11/6/97
PCM Downlink Services CSCI Design Panel Internal Review	11/4/97	11/4/97
PCM Downlink Services CSCI Design Panel	11/6/97	11/6/97
Gateway Common/PCM Downlink Services CSCI Unit Testing	1/2/97	1/16/97
Gateway Common/ PCM Downlink Services CSCI Development Integration Test	1/19/97	1/16/97
Gateway Common/ PCM Downlink Services CSCI Formal Integration Test	2/16/97	2/20/97
Support System Integration Test	2/23/98	3/27/97
Thor Development Complete	3/27/97	3/27/97

1.7.2 Dependencies

No.	Dependency Area	Dependency	Need Date
1	Test Build and Control	PCM Tables	12/12/97

1.8 PCM Interface Thread Simulation Requirements

The PCM Interface Thread will utilize the existing LPS Simulation System with the math models. The PCM Gateways in SDE 1 and SDE 2 will be connected to the VSIs in the LCC via the PCC RCVS and the PCM Gateway in the IDE 1 will be connected to the VSIs via the VSI T/R System.   All simulations will be conducted in the real-time mode.

1.9 PCM Interface Thread Integration and System Test

PCM Interface Thread testing is composed of two major activities:

- Common Gateway Services CSCI/PCM Services CSCI will utilize Gateway Test Tools (Change Data Packet Analyzer/CCP Simulator) for development and formal CSCI Integration Testing.   A network analyzer may also be used to verify packet structure, data content and timing information.
- System Integration and Test will develop a test plan and test procedures to verify end to end data flow through the system

1.10 PCM Interface Thread Training Requirements

None.

1.11 PCM Interface Thread Facilities Requirements

None.

1.12 PCM Interface Thread Travel Requirements

TBD: Sail testing at JSC may be required

1.13 PCM Downlink Thread Action Items/Resolution

See issues listed in individual CSCI assessments.

2. PCM Interface Thread CSCI Assessments

2.1 PCM Downlink CSCI Assessment

PCM Process Control CSC Work Required

- PCM Process Control is responsible for the initialization of the FEPC card.
- PCM Process Control will load TCID Tables as part of FEPC initialization.
- PCM Process Control will receive C-to-C Commands, then redistribute them to appropriate CSC based on the routing code.
- As command, PCM Process Control will display TCID Tables, Telemetry Interface Card (TIC) and FEPC health & Status locally.
- PCM Process Control is also responsible for the FEPC Termination.

PCM Measurements Processing CSC Work Required

- PCM Measurement Processing will process significant change on measurements.
- PCM Measurement Processing will convert measurements to standard IEEE-754 floating point engineering unit form.
- PCM Measurement Processing will provide Engineering unit Conversion and Calibration on Analog Measurements
- PCM Measurement Processing will provide measurement processing of analog, digital pattern, multi-word digital pattern, and discrete group data types
- PCM Measurement Processing will process 20,000 measurements per second.

PCM Command Processing CSC Work Required

- PCM Command Processing will process Status MDT command
- PCM Command Processing will process Status LDT command
- PCM Command Processing will process request to alter the significant change for each analog measurement.
- PCM Command Processing will provide status of measurement parameters
- PCM Command Processing will process Table maintenance command
- PCM Command Processing will process 10 commands per second

PCM Decommutation CSC Work Required

- PCM Decommutation will process Activate/Inhibit Data Acquisition commands
- PCM Decommutation is responsible for configuring the PCM telemetry interface card as a part of ADA.
- PCM Decommutation will process OI, and GPC downlist data.
- PCM Decommutation will process Change Sync Bits command
- PCM Decommutation will process Change Decom Area Assignment command
- PCM Decommutation will process PCM Source Select command
- PCM Decommutation will process Format Change command

CSCI Assessment

CSC Name	CSC Labor (LM)	% of CSC
PCM Process Control	4	10
PCM Measurements Processing	4	30
PCM Command Processing	2	10
PCM Decommutation	6	40
Total (Thor Only)	16	

Basis of estimate

- PCM Process Control is estimated to be approximately 1000 lines of code.
- PCM Measurements Processing is estimated to be approximately 1500 lines of code. But approximately 300 out of 1500 lines of code are reused code from JSC.
- PCM Command Processing is estimated to be approximately 1000 lines of code.
- PCM Decommutation is estimated to be approximately 2500 lines of code. But approximately 400 out of 2500 lines of code are reused code from the PCM Simulator project.

Documentation

Document Type	New/Update	Number of Pages
Requirements and Design Documentation	New	20
Users Guide	New	5
Test Procedure	New	50

Assumptions

The GCP Service API is implemented under Gateway Common Services CSCI.
The PCM Subsystem Integrity CSC is implemented under Gateway Common Services CSCI.
The PCM gateway will use the existing PCM telemetry card model #4422 built by Berg Systems International for Thor delivery.

Open Issues

None

2.2 Test Build and Control Assessment

The Test Build and Control CSCI will include support for multi-format PCM data.

CSC DBSAFE Work Required

DBSAFE will be modified as required to support PCM FDs. A new gateway will be created for PCM. DBSAFE will provide a capability to specify mission specific flight file definition. Delete any CCMS specific information from DBSAFE that isn't required by CLCS.

CSC FD Directory Work Required

Provide any changes necessary in FD Directory and OLDB to support PCM Processing.

CSC CLCS Gateway Table Build Work Required

Create necessary Gateway Tables to support processing of PCM data.

Basis of estimate

CSC Name	CSC Labor (LM)	% of CSC
DBSAFE	tbd	tbd
FD Directory Build	tbd	tbd
Gateway Table Build	18 LM	90%

Documentation

Document Type	New/Update	Number of Pages
Requirements and Design Documentation	update	tbd
Users Guide	update	tbd
API Interface Document	n/a	n/a
Interface Design Document	n/a	n/a
Test Procedure	update	tbd

Assumptions

None

Open Issues

Require the specification of Gateway Table formats before coding can start.

3. PCM Interface Thread HWCI Assessments

PCM Interface Board HWCI Assessment

<u>Labor</u>

Version 1.0   Basic

HWCI Name	HWCI Labor (LM)	% of HWCI
PCM Downlink Interface Board Evaluation	2	100

Equipment

Equipment Type	Quantity	Unit Cost Estimate	Total Cost
PCM Downlink Interface Board	5	$12,000	$60,000
		Total	$60,000

Documentation

Document Type	New/Update	Number of Pages
Requirements and Design Documentation	New	15
Users Guide	COTS	TBD
Drawings	New	4
Interface Design Document	COTS	4
Test Procedure	New	4

Assumptions

None.

Open Issues

None.

4. COTS Products Dependencies

4.1 SW Products Dependency List

Product Name	Quantity Needed	Need Date
VxWorks SENS Release	1	11/1/97

4.2 HW Products Dependency List

Product Name	Quantity Needed	Need Date
SPANS PCI Expansion Modules	3	10/17/97
100BaseT PMC Modules	6	10/1/97
PCM Downlink Interface Board	5	11/24/97
SCSI Disk Drives	3	10/1/97
MVME 2604 SBC w/ 761 Module	3	10/1/97